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EXAMINER	
MONDT, JOHANNES P	
ART UNIT	**PAPER NUMBER**
3663	

DATE MAILED: 01/20/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/773,943	LEE ET AL.	
	Examiner	Art Unit	
	Johannes P. Mondt	3663	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-12,14-19,21-40,43 and 44* is/are pending in the application.

4a) Of the above claim(s) *34-38* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-12,14-19,21-33,39,40,43 and 44* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *11/4/5*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Amendment filed 11/04/2005 forms the basis for this office action. In said Amendment Applicant cancelled claims 3, 13, 20, 41 and 42 and substantially amended all remaining elected claims1-2, 4-12, 14-19, 21-33, 39-40 and 43-44.

Information Disclosure Statement

The examiner has considered the items listed in the Information Disclosure Statement (IDS) filed 11/04/2005. A signed copy of Form PTO-1449 of said IDS is herewith enclosed.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

1. ***Claims 2 and 40*** are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claims contain subject matter not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. In particular, nowhere in the specification do applicants describe how a single optical mode or a few lower-order optical modes are contained in said first structure while said second structure extracts incoherent light from said first structure.

1. ***Claim 33*** is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim contains subject matter not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention.

The limitation, newly introduced within the context of a substantially amended claim 33 as opposed to the original claim 33, that "the substrate layer is separated from the active layer by portions of the first and second structures" (final two lines of claim 33 as substantially amended) lacks disclosure in the original specification. Please note that the claimed photonic crystal as embodied through holes, whether 201 or 203, fails to separate the substrate from the active layer: the substrate is as distant or close to the active layer independent upon the existence of the photonic crystal structure, and hence it cannot be said that said substrate is separated from said active layer by portions of the first and second structures.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. ***Claims 1, 2, 4-5, 14-17, 28-29, 31-32, 39-40 and 43*** are rejected under 35 U.S.C. 102(b) as being anticipated by Erchak et al (Applied Physics Letters 78, 563-565 (2001)). Erchak et al teach a solid state light emitting diode device (see

title and abstract) comprising: an active layer (quantum well and line 4 of second paragraph of first column of page 563; Fig. 1) emitting incoherent light (inherent for light-emitting diodes; see, for instance M. Fukuda, pp. 93 and 123) in response to a current injected into the layer (also inherent to light-emitting diodes); a first structure comprising at least one waveguide layer adjacent to the active layer (region underneath said active layer comprising the high-dielectric layers in DBR trapping the wave by guiding the wave upward; Fig.1 and second paragraph of first column of page 563) trapping the incoherent light generated by the active layer (as light is reflected by said DBR; second paragraph of page 563); and a second structure comprising a photonic crystal structure (photonic crystal in Fig. 1; see central paragraph of second column of page 563) adjacent to the first structure extracting the incoherent light trapped by the first structure (central paragraph of second column of page 563).

On claim 2: the first structure contains substantially a single optical mode (935 nm in one embodiment and at 790 nm in another: see first column of page 565, second and third paragraphs, respectively) and traps the light in said optical mode.

On claim 4: since in DBR layers their thickness approximately corresponds to one quarter of the wavelength this limitation is met by Erchak for the emission of 935 nm and also for the emission of 790 nm wavelength, corresponding to thicknesses equal to about 233 nm and 197.5 nm, respectively.

On claim 5: the device by Erchak et al further comprises a transparent and conductive layer (Al_xO_y layer) over the first structure (second paragraph of first column of page 563).

On claim 14: said photonic crystal structure comprises at least one array of holes in the device (first sentence of second paragraph of first column of page 563; see Fig. 1).

On claim 15: said second structure comprises at least one layer (upper cladding layer; see second paragraph of first column of page 563), wherein the photonic crystal structure comprises at least one array of holes in said at least one layer (second paragraph of first column of page 563; Fig.1).

On claim 16: said at least one array of holes forms a two-dimensional array (first sentence of second paragraph of page 563; see Fig. 1).

On claim 17: as shown by Fukuda it is inherent for a light-emitting diode device to have at least one electrode through which current is injected into the active layer.

On claim 28: said holes form a triangular array (second paragraph of first column of page 563, first sentence; see also Figs. 1 and 4).

On claim 29: a lattice constant of said at least one array of holes is in a range of about 80 to 500 nm, namely: 380 nm (see second column of page 564), and the holes have diameters in the range of about 50 nm to 300 nm, namely: 112 nm (loc.cit.).

On claim 31: the device further comprises a substrate (GaAs substrate: Fig. 1 and final three lines of first column of page 563).

On claim 32: the substrate layer has a band gap wider than that of the active layer (because the band gap of InGaAs is less than that of GaAs, which follows from Vegard's Law and the fact that the band gap of InAs is less than that of GaAs; see Appendix G in S.M. Sze, "Modern Semiconductor Device Physics").

On claim 39: Erchak et al teach a method for emitting light (title and abstract), comprising: injecting electrical current into an active layer (inherent to all light-emitting diodes; see Fukuda), causing the layer to emit incoherent light in response to the current injected into the layer (inherent to light-emitting diodes: see Fukuda); trapping the incoherent light generated by the active layer by means of at least one waveguide layer (DBR layers: Fig. 1 and second paragraph of first column of page 563); and extracting by means of a photonic crystal (second paragraph of first column of page 563, and central paragraph of second column of page 563; and Fig. 1) the incoherent light trapped by the at least one waveguide layer.

On claim 40: the first structure contains substantially a single optical mode (935 nm in one embodiment and at 790 nm in another: see first column of page 565, second and third paragraphs, respectively) and traps the light in said optical mode.

On claim 43: the injection injects current into the active layer from both p- and n-type conductivity sides, inherently so in light-emitting diodes, and hence

also from upper clad layer in which said photonic crystal is made (second paragraph of first column of page 563) into the active layer, and hence away from the photonic crystal structure (see Fig. 1).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. ***Claim 6*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al as applied to claim 1, in view of Schubert et al (Applied Physics Letters 60(8), 921-923 (1992)).

Erchak et al teach the device to further comprise at least one cladding layer adjacent (i.e., near) the waveguide layer (upper InGaP cladding layer: see Figure 1 and second paragraph of first column of page 563), however Erchak et al do not necessarily teach the further limitation that the refractive index of said cladding layer is to be lower than that of the wave guide layer.

However, it would have been obvious to include said further limitation in view of Schubert et al, who, in a publication on a vertically emitting light-emitting diode with distributed Bragg reflector layers, hence analogous art, teach to include an upper DBR, however, with less reflectivity (first paragraph of first column of page 563), and hence with lower refractive index.

4. ***Claim 7-8*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al and Schubert et al as applied to claim 6, and further in view of Kung et al (6,420,732 B1).

As detailed above, claim 6 is unpatentable over Erchak et al in view of Schubert et al.

Erchak et al nor Schubert et al necessarily teach the further limitation that the device further comprises a transparent conductive layer over the at least one waveguide layer.

However, it would have been obvious to include a indium tin oxide (ITO) layer over the at least one cladding layer in view of Kung et al, who, in a patent on a light emitting diode with improved light extraction efficiency (see title and abstract), hence closely related to Erchak et al, teach the inclusion of a transparent and conductive layer 52 (Figure 4 and col. 10, l. 13-27), the only material being cited in this regard being ITO (indium tin oxide) (see coil. 4, l. 36-43).

Motivation to include the teaching by Kung et al in the invention by Erchak et al derives from the beneficial effect of transparency of an electrode in the path of light to be extracted, given the common objective of light extraction improvement (title in Kung et al, and abstract in Erchak et al).

Combination is easily achieved by selecting an ITO layer for the inherently necessary upper electrode in Erchak et al.

With regard to claim 8: furthermore, ITO inherently is electrically conductive, substantially transparent and has an index of refraction of about 1.8 while said ITO layer

when being the upper electrode inherently is interface between the light-emitting device and other media, such as either interconnect or voltage source.

1. ***Claims 9 and 10*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al, Schubert et al and Kung et al as applied to claim 7 above, and further in view of Moller et al (US 2003/0020399 A1). As detailed above, claim 7 is unpatentable over Erchak et al and Schubert et al in view of Kung et al, none necessarily teaching the thickness range for the ITO layer as claimed. However, it would have been obvious to select the thickness within said range in view of Moller et al, who, in a patent application on intensity enhancement of the light emitting device (title), hence closely related to Erchak et al, teach the thickness of the anode electrode, chosen to be of ITO inter alia for transparency, to be 100 nm (see [0004]), which falls in the range of 30 nm – 300 nm (claim 9), and within the ranges 89 nm – 640 nm and 65 nm – 470 nm (claim 10).

Applicant is furthermore reminded that a *prima facie* case of obviousness typically exists when the ranges as claimed overlap the ranges disclosed in the prior art or when the ranges as claimed do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Motivation for the selection of the thickness within said range stems at least from the requirements of transparency and conductance.

2. ***Claim 11*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al, Schubert et al and Kung et al as applied to claim 7 above, and further in view of

Fukuoka et al (US 2001/0000943 A1). Although neither Erchak et al nor Schubert et al nor Kung et al necessarily teach the further limitation defined by claim 11 it would have been obvious to include said further limitation in view of Fukuoka et al, who in a patent application drawn to light emitting devices with transparent (ITO) electrodes teach the selection of the thickness of the transparent electrodes to be in the preferable range of 10 nm – 200 nm for ITO (see par. [0154]), hence n = 1.8, and for a peak wavelength of about 470 nm (see Figure 6; see par. [0105]), yielding approximately 60 nm for $\lambda/(4n_{ITO})$, which is centrally located in said preferable range for the ITO electrode thickness, thus meeting the range as claimed, namely the range "substantially equal to $\lambda / (4\ n_{ITO})$" within the prior art range.

Applicant is reminded that it has been held that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art or when the ranges of a claimed composition do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

3. ***Claim 12*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al, Schubert et al and Kung et al as applied to claim 7 above, and further in view of Chu et al (US 2002/0117672 A1). Although neither Erchak et al nor Schubert et al nor Kung et al necessarily teach the further limitation defined by claim 12, it would have been obvious to include said further limitation in view of Chu et al, who, in a patent application drawn to a light-emitting device with improved light extraction (see title and abstract) teach the inclusion underneath the transparent ITO electrode layer of a ohmic-

contact-enhancing thin Ni/Au layer (see abstract), so as to be able to increase light extraction (through the transparent ITO layer while the Ni/Au layer is made to be extremely small (see abstract) while decreasing the contact resistance through inclusion of said Ni/Au layer (see abstract). *Motivation* to include the teaching by Chu et al thus derives from the improved ohmic contact resistance while the light extraction efficiency is not significantly compromised.

4. ***Claims 18-19 and 21*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al (as applied to claim 17 above) in view of Kung et al (6,420,732 B1). *As detailed above, claim 17 is anticipated by Erchak et al. Erchak et al do not necessarily teach* the further limitation on grid-shaped pattern or pattern with hexagonal openings according to *claim 18.* However, it would have been obvious to include said further limitation in view of Kung et al, who teach the electrode layer 52 to have a grid-shaped pattern conforming the pattern of the underlying contact layer with holes collinear with the holes therein to "further reduce the absorption of light" (col. 10, l. 12-28 in Kung et al: see Figures 4 and 24-26). *Motivation* thus derives at once from the improved extraction efficiency, which is the goal of Erchak et al. In the combined invention thus obtained *claim 19* is met, because the second structure comprises a plurality of holes, each array located so that it is enclosed by a grid cell or exposed through a hexagonal opening (see Erchak et al, second paragraph of first column of page 563) said at least one patterned electrode layer, wherein each array extracts light from the first structure and causes the extracted light to escape through a corresponding hexagonal opening (60 in Kung et al; cf. Figures 6, 24-26) of the electrode layer , or an area bounded by

adjacent strips 52 of a grid-shaped electrode layer (loc.cit.). With regard to claim 21, a triangular array is the inherent property of a photonic crystal with hexagonal holes as without said triangular array no translational invariance can be preserved, said translational invariance being a criterion for crystal property.(Bravais lattice).

5. ***Claim 22-26 and 43-44*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al and Kung et al as applied to claim 18 above, and further in view of Baur et al (WO 01/91194 A1). Although neither Erchak et al nor Kung et al necessarily teach the further limitation as defined by *claim 22*, it would have been obvious to include said further limitation in view of Baur et al, who, in patent application drawn to a light-emitting device (abstract), hence closely related to the combined invention, teach the electrode layer 6 (page 14, lines 27-37) to comprise elongated strips forming a network (loc.cit.), wherein the width of the strips is in the range as claimed, namely 3 μm (loc.cit.), so as to increase the external quantum efficiency (see abstract) further by allowing a reduction of the portion of surface area covered by the electrode layer. *Motivation* immediately flows from the resulting increase in light yield.

On claims 23-25: although Erchak et al nor Kung et al necessarily teach the further limitation defined by *claim 23* it would have been obvious to include said further limitation in view of Baur et al, who teach said LED to comprise a plurality of light emitting portions (in between the members of the mesh: see page 14, lines 27-37) or semiconductor chips, said at least one electrode layer comprising a network (page 14, line 35) on each chip enclosing at least one light extraction cell (necessarily defined

here to be the cell with the nearest members of the electrode mesh as boundaries) so as to provide in spite of the need for providing electrical contact an increase in the light extraction efficiency (see abstract). When included in the combined invention said light extraction cells are the photonic crystal cells because light extraction takes place exclusively within the latter. In the combined invention including the teaching by Baur et al said network comprises a plurality of grid cells (units of the mesh), each enclosing a photonic crystal cell (*claim 24*), while the mesh is taught to be rectangular (see Figures 7 and 8) (*claim 25*), and while each grid cell has a dimension in a range substantially overlapping the range defined by *claim 26*, namely within 0.1 μm – 1 mm, being 3 μm (page 14, lines 35-36). Applicant is reminded in this regard that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art or when the ranges of a claimed composition do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Motivation to include the teaching by Baur et al thus immediately flows from the resulting increased light extraction efficiency.

6. ***Claim 27*** rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al (as applied to claim 17 above) in view of Kung et al (6,420,732 B1). As detailed above, claim 17 is anticipated by Erchak et al. However Erchak et al do not necessarily teach the further limitation defined by claim 27. However, ti would have been obvious to include said further limitation in view of Kung et al, who teach to include a central electrode layer portion 53 of transparent oxide layer 52 (said portion 53 qualifies on its

own as "the at least one electrode layer") so as to provide an improved current blocking structure (col. 11, l. 3-19). *Motivation* to include the teaching by Kung et al derives from the increase in current arriving at the light-producing pn-junction (loc.cit.).

.*Response to Arguments*

Applicant's arguments filed 11/04/2005 have been fully considered but they are not persuasive. Applicant substantially amended all claim language and most of the arguments in traverse of the rejections are strongly dependent upon said claim language *as amended.* Furthermore, the amendment "incoherent light" (claim 1, lines, 2, 4 and 6; and claim 39, lines 2, 4 and 6) does nothing to distinguish the application from Hirayama et al, because even in a laser, the active region emits incoherent radiation in the first instance. That said incoherent radiation is subjected to lasing and thereby the output is made to be coherent is a different matter.

Furthermore, Applicant's remark that claim 33 has been amended such that it overcomes the objection to the specification is not substantiated by any explanation and is not true: hole 203 does not cause the "substrate layer to be separated from the active layer by portions of the first and second structure", because a straight line can be drawn from said substrate to said active layer without intersecting with hole 203, such that said straight line, by the distance between the closest pair of points on substrate and active layer, respectively, defines the distance between said substrate and said active layer. The limitation that said substrate and said active layer are separated by *portions* of the first and second structure actually constitutes new matter, having not been disclosed by

the application in its original form including the original claim language. The teaching that holes of the photonic crystal penetrate other layers including the active layer and DBR layers placed both above and below said active layer can be found in related prior art on light extraction means, as witnessed by Deng et al (6,704,343 B2) (column 5, lines 4-11), yet it cannot be said that therefore portions of the second structure (photonic crystal) separate the substrate from the active layer, because the distance between substrate and active layer is measurable along a line that does not intersect with said holes. This is the only reason why an art rejection based on the teaching by Deng et al is not included in the present office action, because the teaching on hole 203 by Applicant in no manner differs from the prior art by Deng et al.

In view of the complexity of the new claim language and the duty of examiner to provide the best art at each office action new primary references (Erchak et al, Applied Physics Letters 78, 563-565 (2001))and Schubert et al, Applied Physics Letters 60(8), 921-923 (1992)) is provided on which the art rejections herewith provided are based.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

Parker et al (US 2005/009456 A1 (as made of record by Applicant in IDS filed 11/04/2005).

Deng et al (6,704,343 B2) (title, abstract, columns 3-6; Figures 1-4; see comments overleaf).

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P. Mondt whose telephone number is 571-272-1919. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack W. Keith can be reached on 571-272-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

JPM
January 15, 2006

JACK KEITH
SUPERVISORY PATENT EXAMINER